

# Insulin injection rotation and Diabetes Mellitus nutritional management education

Indah Rosdiana Narahaubun,<sup>1</sup> Dian Handayani,<sup>2</sup> Heri Kristianto<sup>1</sup>

<sup>1</sup>Department of Nursing, Faculty of Health Sciences, Universitas Brawijaya, Malang, East Java;

<sup>2</sup>Department of Nutrition, Faculty of Health Sciences, Universitas Brawijaya, Malang, East Java, Indonesia

## Abstract

The management of Diabetes Mellitus (DM) involves implementing a healthy lifestyle and pharmacological interventions through the administration of anti-hyperglycemia drugs. An essential aspect of treating DM patients is insulin administration, which facilitates glucose transportation into cells. This study evaluated the effectiveness of insulin injection rotation and nutritional management education for DM. The literature search utilized the keywords “education,” AND “insulin injection,” AND “nutritional management,” AND “DM”, ranged 2021-2023 Searches were conducted on various databases, including Proquest, NCBI, BMC, ScienceDirect, and other relevant platforms such as Google Scholar. Ten journal articles pertinent to the subject matter were identified in the study. Findings indicate that nutritional education facilitates overall health improvement in individuals with DM, contributing to maintaining average body weight and near-normal blood glucose levels. It also enhances lipid profile and insulin receptor sensitivity while being a preventive measure against acute or chronic complications such as hyperglycemia. It is noted that selecting the appropriate injection site can significantly impact patients' blood glucose levels. While it is recommended to administer injections at consistent locations, repetitive use of the same site may pose risks of side effects, such as lipodystrophy. After conducting a comprehensive review of ten journal articles, it has been concluded that insulin injection rotation and nutritional management education are effective for managing DM.

## Introduction

A total of 422 million Diabetes Mellitus (DM) patients were reported by the data obtained from the World Health Organization (WHO) and International Diabetes Federation (IDF) in 2019. Approximately 10.7 million patients are in the age range of 20-79 years, and the figure is estimated to increase by 11.8% in 2030 and 2045<sup>1</sup> due to the high incidence of the disease. According to the 2018 Riskesdas data, the prevalence of DM patients aged over 15 years remained at 2%, marking an increase compared to the figures from the 2013 Riskesdas.<sup>2</sup>

The management can be achieved by implementing a healthy lifestyle with pharmacological intervention and administration of anti-hyperglycemia drugs.<sup>3-6</sup> The management of type 2 DM restores blood glucose concentration, allowing patients to feel comfortable and healthy as well as preventing the onset of micro complications and macrovascular complications.<sup>7-9</sup> Individuals who have been diagnosed with diabetes often need to rely on insulin therapy to help move glucose from the blood into the body's cells. This essential process is critical in managing the condition and maintaining proper blood sugar levels.<sup>10-12</sup>

Selection of the right insulin injection site can affect the blood glucose levels of patients. Therefore, changing the injection point is important to prevent the risk of side effects. Lipodystrophy is a side effect of insulin resulting from fat tissue damage to form scars in the form of lumps under the skin. These lumps can interfere with insulin absorption and repetitive injection can cause other complications in the form of skin irritation.<sup>13-15</sup> A strong understanding of nutritional treatment can play a crucial role in helping to stabilize blood glucose levels and support overall health.<sup>16-17</sup>

Nutritional education improves the general health of DM patients, maintains normal body weight and near-normal blood glucose levels, improves lipid profiles and insulin receptor sensitivity, as well as prevents acute or chronic complications such as hyperglycemia.<sup>17-19</sup> Achieving success in DM management requires diligent adherence to the guidance provided by healthcare professionals, including physical exercise, pharmacological treatment, and dietary recommendations. Therefore, this research aimed to determine the effectiveness of insulin injection rotation and nutritional management education for DM.

## Materials and Methods

### Eligibility criteria

The articles underwent a rigorous evaluation based on specific criteria and were managed using bibliographic software like Mendeley. The assessment was carried out meticulously through a systematic three-step review to determine their suitability for inclusion in the study. This comprehensive process involved the initial scrutiny of the title, abstract, and full text. The inclusion cri-

### Significance for public health

*The management of Diabetes Mellitus (DM) entails adopting a healthy lifestyle, utilizing anti-hyperglycemic medications, and administering insulin. Proper selection and rotation of injection sites are imperative to mitigate potential side effects. This research emphasizes the significance of nutritional education in enhancing overall health and averting complications in DM patients.*

teria encompassed articles published within the past three years (2021-2023), original qualitative and quantitative research, content relevant to the specified search terms, and availability as open access. The exclusion criteria included content irrelevant to the topics.

### Search strategy

An extensive electronic search was conducted across five databases: Proquest, NCBI, BMC, ScienceDirect, and Google Scholar. The search period ranged from 2021 to 2023, focusing on specific keywords including “Education,” AND “Insulin Injection,” AND “Nutritional Management,” AND “Diabetes Mellitus.” Following the retrieval of articles, predefined inclusion criteria were applied to filter the results and identify relevant content for further analysis.

### Article selection process

The review article selection process employed the PRISMA method. A comprehensive search across Proquest, NCBI, BMC, ScienceDirect, and Google Scholar yielded 39,490 articles. Following filtering based on specified year criteria, the number was refined to 19,728. Subsequently, a thorough evaluation of the title and abstract and a scoping review identified 30 suitable articles. Finally, after the third stage of screening, 16 articles were selected (Figure 1). Articles selected shown in *Supplementary materials, Table 1*.

## Results and Discussion

### Optimizing the administration of insulin injections

Insulin, a vital hormone, is pivotal in regulating the body’s glucose levels. The degree of insulin sensitivity varies among individuals and is influenced by diverse lifestyle and dietary factors. Notably, approximately 40% of adults in the United States experience low insulin sensitivity, also known as insulin resistance, which elevates the risk of developing type 2 diabetes. Improving insulin sensitivity and diminishing insulin resistance can yield significant benefits for individuals with type 2 diabetes or those predisposed to the condition. Embracing positive lifestyle modifications, such as regular physical activity and a well-balanced diet, can substantially enhance insulin sensitivity and mitigate the risk of type 2 diabetes.<sup>20</sup>

The efficacy of diabetes therapy hinges on the accurate administration of insulin through proper injection techniques. Despite existing guidelines and evidence, it is imperative to identify barriers to this technique among patients and foster awareness among patients and healthcare professionals regarding the significance of refining insulin injection practices.<sup>21</sup>

Administration of insulin injections necessitates careful attention to optimizing patient care. A study by Zhang and Chen elucidated the specific requirements for this procedure. Compared to the control group, the cohort receiving consistent care and optimized insulin injection techniques demonstrated marked enhancements in health. These improvements included decreased blood glucose and HbA1c levels, fewer reported insulin-related complications and reduced pain scores. Additionally, the intervention group exhibited expedited training and achieved a higher success rate for initial subcutaneous injections. Moreover, the intervention group experienced a lower frequency of subcutaneous fat hyperplasia. Conversely, while not statistically significant, the control

group displayed a higher incidence of hypoglycemia.<sup>22</sup> A study compared the effects of IT education on diabetes management in two groups. Both groups had similar demographics and baseline IT behaviour. HbA1c reduction was similar in both groups in the intention-to-treat analysis but significant in the per-protocol analysis. Total daily dose (TDD) insulin changes were more important in the IT education group. Control patients showed “contamination” of IT education behaviours, decreasing HbA1c.<sup>23</sup> A new automatic insulin injection log device with an algorithm improved injection rotation in the abdominal area, potentially reducing lipo hypertrophy lesions and promoting better glucose control.<sup>24</sup>

The prevalence of lipohypertrophy among individuals with diabetes mellitus is notably high, linked to insufficient health education on proper injection techniques. Implementing a system of rotating injection sites has been shown to enhance glycemic control in both type 1 and type 2 diabetes mellitus subjects. Moreover, it has been observed that the level of education influences glucose control in type 1 diabetes mellitus subjects. However, further comprehensive research is necessary to extrapolate these findings and to establish definitive causal relationships between injection techniques and glycemic control.<sup>25</sup>

Proper insulin administration is paramount to avoiding serious complications. Healthcare providers must educate patients on appropriate techniques, insulin storage, injection sites, and potential complications to mitigate errors resulting from a lack of knowledge. Effective diabetes management relies on healthcare providers’ assessment of patient understanding and utilization of engaging educational methods. Given time constraints, physicians require support in effectively educating and providing patient feedback. Notably, patients improved their injection technique during follow-up visits by addressing factors such as injection force and

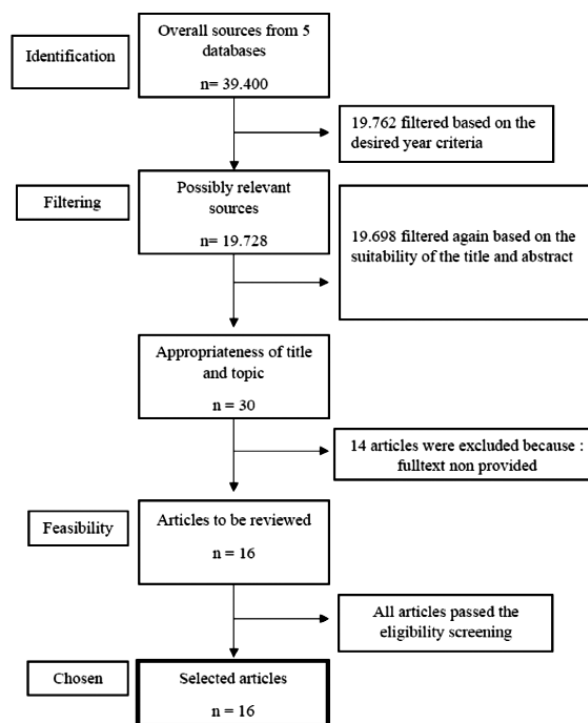


Figure 1. Article selection process.

area size. Educational interventions to improve insulin injection techniques can potentially enhance glycemic control in individuals with diabetes mellitus. It is imperative to incorporate evidence-based recommendations and guidelines for insulin injection techniques and adopt technological and innovative solutions to advance this endeavour.<sup>26-28</sup>

### Improving nutritional management for patients with type 2 diabetes mellitus

Type 2 diabetes is characterized by impaired glucose utilization and energy storage, leading to elevated blood sugar levels. Insulin resistance, a hallmark of this condition, impedes the entry of sugar into cells, while insufficient insulin production by the pancreas further contributes to the increased blood sugar levels.<sup>29</sup> Effectively managing type 2 diabetes necessitates lifestyle modifications, self-care practices, and medication to prevent complications associated with the eyes, kidneys, and nerves. Regular monitoring of blood sugar levels, as well as the regulation of blood pressure and cholesterol, are vital aspects of management. Adhering to a nutritious diet, engaging in physical activity, and adhering to prescribed medications are integral to diabetes management. Seeking guidance from a qualified dietitian is advantageous in formulating a personalized plan that aligns with individual needs and preferences.<sup>8</sup>

The preceding study elucidates the nutritional enhancements following a targeted dietary intervention.<sup>30-35</sup> A study focused on two individuals aged 39 and 67 with low body weights and BMIs. Their nutritional deficiencies were addressed through assessments, oral hygiene interventions, and diabetes-specific dietary education. Following the educational session, the patient's weight and BMI showed improvement.<sup>30</sup> Before the educational interventions, 70.5% of the patients had poor blood sugar levels, with 47.7% exhibiting moderate levels. Adherence to dietary recommendations notably impacted the blood sugar levels of individuals with type II diabetes.<sup>31</sup> The study involved 159 patients divided into three groups, resulting in varied outcomes. The intervention group significantly improved HbA1c levels, metabolic parameters, dietary intake, and physical activity.<sup>34</sup>

While healthcare providers recognized challenges in maintaining a healthy diet, patients demonstrated positive self-management indicators.<sup>34-35</sup> Healthcare providers hold diverse perspectives regarding patients' challenges in maintaining a healthy diet. Some patients demonstrate proactive self-management behaviours, such as consistently monitoring their blood glucose levels and displaying a strong interest in acquiring knowledge about dietary practices. Nevertheless, providers have indicated that they often lack the necessary time to engage in extensive discussions about diet with their patients and would prefer to delegate dietary education to other individuals.<sup>36</sup>

Managing diabetes well involves learning about it, planning meals, staying active, taking medication as prescribed, and checking blood sugar levels regularly. Modalities encompass insulin therapy, oral medications, complementary and alternative medicine, surgical interventions, and lifestyle modifications. The rotation of insulin injections and nutritional knowledge significantly impact diabetes management and overall understanding. Healthcare professionals employ counselling techniques and provide educational resources to enhance treatment outcomes.

## Conclusions

In conclusion, the effective management of diabetes mellitus (DM) can be enhanced by implementing five key pillars: education, meal planning, physical exercise, pharmacological intervention, and blood sugar monitoring. Treatment options comprise insulin therapy, oral medications, exploration of alternative therapies, surgical interventions, and lifestyle improvements such as dietary modifications and regular exercise. The proficient rotation of insulin injections and provision of nutritional education significantly impact patients' blood glucose control and knowledge levels. Healthcare professionals deliver education through counselling and the distribution of educational materials, including booklets, leaflets, and modules, to augment treatment success.

## References

1. Setyawati AD, Ngo THL, Padila P, Andri J. Obesity and Heredity for Diabetes Mellitus among Elderly. *JOSING* 2020;1:26–31.
2. Ministry of Health Republic of Indonesia. Basic Health Research. Jakarta: Ministry of Health Republic of Indonesia; 2018.
3. Perkeni. Management and Prevention of Type 2 Diabetes Mellitus in Indonesia. Jakarta: Indonesian Endocrinology Society; 2021.
4. Fujiwara Y, Eguchi S, Murayama H, et al. Relationship between diet/exercise and pharmacotherapy to enhance the GLP-1 levels in type 2 diabetes. *Endocrinol Diabetes Metab* 2019;2:e00068.
5. Davies MJ, Aroda VR, Collins BS, et al. Management of Hyperglycemia in Type 2 Diabetes, 2022. A Consensus Report by the American Diabetes Association (ADA) and the European Association for the Study of Diabetes (EASD). *Diabetes Care* 2022;45:2753–86.
6. Nathan DM, Buse JB, Davidson MB, et al. Medical management of hyperglycemia in type 2 diabetes: a consensus algorithm for the initiation and adjustment of therapy: a consensus statement of the American Diabetes Association and the European Association for the Study of Diabetes. *Diabetes Care* 2009;32:193-203.
7. Rasyid W, Nur BM, Irawati D, Rayasari F. Effectiveness of Insulin Injection Time on Blood Glucose Levels 2 Hours After Meals in Type 2 Diabetes Mellitus Patients. *JKS* 2019;2(2):39–52.
8. Goyal R, Singhal M, Jialal I. Type 2 Diabetes. [Updated 2023 Jun 23]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan-. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK513253/>
9. Mehravar F, Mansournia MA, Holakouie-Naieni K, et al. Associations between diabetes self-management and microvascular complications in patients with type 2 diabetes. *Epidemiol Health* 2016;38:e2016004.
10. Thota S, Akbar A. Insulin. [Updated 2023 Jul 10]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan-. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK560688/>
11. Donnor T, Sarkar S. Insulin- Pharmacology, Therapeutic Regimens and Principles of Intensive Insulin Therapy. [Updated 2023 Feb 15]. In: Feingold KR, Anawalt B, Blackman MR, et al., editors. *Endotext* [Internet]. South

- Dartmouth (MA): MDText.com, Inc.; 2000-. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK278938/>
12. Lukito JI. Use Insulin Carefully. *CDK* 2020;47:734.
  13. Syarfaini, Ibrahim IA, Syahrir S, et al. The Effect of Nutrition Education on Knowledge and Self-Management in Type 2 Diabetes Mellitus Patients. *AI GIZZAI: Public Health Nutr J* 2023;33–42.
  14. Mehrabbeik A, Namiranian N, Azizi R, et al. Investigation of Association Between Insulin Injection Technique and Blood Glucose Control in Patients with Type 2 Diabetes. *Int J Endocrinol Metab* 2022;20:e128392.
  15. Kadiyala P, Walton S, Sathyapalan T. Insulin induced lipodystrophy. *Br J Diabetes* 2014;14:131–3.
  16. Reynolds A, Mitri J. Dietary Advice For Individuals with Diabetes. [Updated 2024 Apr 28]. In: Feingold KR, Anawalt B, Blackman MR, et al., editors. *Endotext* [Internet]. South Dartmouth (MA): MDText.com, Inc.; 2000-. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK279012/>
  17. Liang K, Xie Q, Nie J, Deng J. Study on the effect of education for insulin injection in diabetic patients with new simulation tools. *Medicine* 2021;100:e25424.
  18. Gortzi O, Dimopoulou M, Androutsos O, et al. Effectiveness of a Nutrition Education Program for Patients with Type 2 Diabetes Mellitus. *Appl Sci* 2024;14:2114.
  19. Kim J, Hur MH. The Effects of Dietary Education Interventions on Individuals with Type 2 Diabetes: A Systematic Review and Meta-Analysis. *Int J Environ Res Public Health* 2021;18:8439.
  20. Freeman AM, Acevedo LA, Pennings N. Insulin Resistance. [Updated 2023 Aug 17]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan-. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK507839/>
  21. Kalra S, Pathan F, Kshanti IAM, et al. Optimising Insulin Injection Techniques to Improve Diabetes Outcomes. *Diabetes Ther* 2023;14:1785–99.
  22. Zhang FY, Shen M, Sun LQ. Evaluation of clinical efficacy of continuous care with improved insulin injection techniques on patients with diabetes mellitus: a randomized controlled trial. *J Int Med Res* 2022;50:3000605221108047.
  23. Chen L, Xing Q, Li J, et al. Injection Technique Education in Patients with Diabetes Injecting Insulin into Areas of Lipohypertrophy: A Randomized Controlled Trial. *Diabetes Ther* 2021;12:813–26.
  24. Klarskov CK, Hamid YH, Tjalk-Bøggild R, et al. A new medical device for improved rotation of insulin injections in type 1 diabetes mellitus: a proof-of-concept study. *J Diabetes Sci Technol* 2021;15:1111–20.
  25. Abujbara M, Khreisat EA, Khader Y, Ajlouni KM. Effect of Insulin Injection Techniques on Glycemic Control Among Patients with Diabetes. *Int J Gen Med* 2022;15:8593–602.
  26. Louzolo-Kimbembe R, Jaafari F, Rafi S, Mghari G, EL ansari N. Insulin Injection A Non-Trivial Act with Sometimes Serious Consequences: Major Role of Therapeutic Education. *SAS J Med* 2021;7:47–9.
  27. Adhi IGAM, Dwiatmojo NF, Sukmadewi NLP, et al. Effectiveness of Rotation Scheme for Insulin Injection on Blood Sugar Control of Diabetes Mellitus Patients in the Polyclinic of North Lombok District Hospital. *JISIP* 2023;7:830–6.
  28. Bari B, Corbeil MA, MacNeill G, et al. Addressing Insulin Injection Technique: A Follow-up Study of Canadian Patients with Diabetes. *Diabetes Ther* 2023;14:2057–74.
  29. Nakrani MN, Wineland RH, Anjum F. Physiology, Glucose Metabolism. [Updated 2023 Jul 17]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan-. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK560599/>
  30. Lukman L, Aguscik A, Agustin VA. Implementation Of Nutrition Management In Nursing Care For Type II Diabetes Mellitus With Nutrition Deficit Nursing Problems. *Jurnal 'Aisyiyah Medika* 2023;8(1).
  31. Pangaribuan GJ, Wahyu A. The Effect Of Diet Compliance Education On Blood Sugar Levels In Type Ii Diabetes Mellitus Patients In The 7th Floor Inpatient Care, Murni Teguh Hospital, Medan. *Asy-Syfa* 2023;1:34–42.
  32. Sitorus F, Waruwu KNR, Tolnel RE, Bexty F. Knowledge and Compliance of Type 2 Diabetes Mellitus Patients with Diabetic Nutrition Management. *J Nursing Library* 2023;2:40–45.
  33. Momongan N, Paruntu O, Barangmanise S, Takahipe N. Diet Education With Booklet Media In Improving Diet Compliance And Blood Sugar Levels In Type II DM Patients. *Gizido Journal* 2021;13:24–2.
  34. Isaksson SS, Bacos MB, Eliasson B, et al. Effects of nutrition education using a food-based approach, carbohydrate counting or routine care in type 1 diabetes: 12 months prospective ran-

Correspondence: Indah Rosdiana Narahaubun, Department of Nursing, Faculty of Health Sciences, Universitas Brawijaya, Jl. Puncak Dieng, Kuncu, Kalisongo, Kec. Dau, Malang, East Java, Indonesia, 65151. Tel.: +62341569117- Fax: +62341564755. E-mail: indahnarahaubun05@gmail.com

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- domized trial. *BMJ Open Diabetes Research and Care* 2021;9:e001971.
35. Hashim SA, Mohd Yusof BN, Abu Saad H, et al. Effectiveness of simplified diabetes nutrition education on glycemic control and other diabetes-related outcomes in patients with type 2 diabetes mellitus. *Clin Nutr ESPEN* 2021;45:141-9.
36. Bross R, Genter P, Lu Y, et al. Barriers to Healthy Eating and Diabetes Diet Education: Divergent Perspectives of Patients and Their Providers. *Health Education Behavior* 2022;49:658-666.

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*Online supplementary materials*  
*Table 1. Selected articles*

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